NISTIR 6588

FIFTEENTH MEETING OF THE UJNR PANEL ON FIRE RESEARCH AND SAFETY MARCH 1-7, 2000

VOLUME 2

Sheilda L. Bryner, Editor

National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

NISTIR 6588

FIFTEENTH MEETING OF THE UJNR PANEL ON FIRE RESEARCH AND SAFETY MARCH 1-7, 2000

VOLUME 2

Sheilda L. Bryner, Editor

November 2000

U. S. Department of Commerce
Norman Y. Mineta, Secretary
Technology Administration
Dr. Cheryl L. Shavers, Under Secretary of Commerce for Technology
National Institute of Standards and Technology
Raymond G. Kammer, Director

A RESEARCH AGENDA FOR FIRE PROTECTION ENGINEERING*

Morgan J. Hurley, P.E.
Technical Director
Society of Fire Protection Engineers
7315 Wisconsin Ave., #1225W
Bethesda, MD 20814

EXECUTIVE SUMMARY

On October 21 & 22, 1999 the Society of Fire Protection Engineers conducted a workshop to develop a research agenda for the fire protection engineering profession. The 70 attendees came from around the world and from all segments of fire protection engineering practice: consulting, insurance, education, research, manufacturing, enforcement and facilities management (a listing of attendees is included at the end of this paper). The workshop attendees identified research priorities in the four areas: increased utility of risk concepts, increased understanding of fire phenomena, human behavior and data.

WORKSHOP PROCESS

The workshop was held for 1-1/2 days, beginning on the morning of October 21. Following welcoming remarks and a summary of workshop goals, keynote presentations were given by Joseph Moakley (a champion in the U.S. Congress of fire safety), James Quiter (senior vice president of the RJA Group, a fire protection engineering firm) and John Nutt (former chairman of Ove Arup & Partners, an international engineering firm). These presentations were intended to help participants focus their thoughts on research needs and the benefits of fire research. Participants were then divided into five breakout groups. Each breakout group was comprised of a cross section of the workshop attendance. Each breakout group met three times, and each meeting had a different goal.

The first time that breakout groups met, participants were asked to identify fire protection problems that they had encountered in the course of their work. In the second meeting of the breakout groups, research needs were identified that would help overcome the problems identified.

Following the second meeting of the breakout groups, the plenary session was reconvened. A keynote presentation was given by Paul Fitzgerald (executive vice president of FM Global) on the benefits of fire research to business and on how those benefits are often long in coming and difficult for businesses to recognize. The breakout groups then met for a third and final time on the morning of the second day to prioritize the needs that they identified and give their perspectives on implementation of the research agenda.

---

* The full research agenda report can be found in "A Research Agenda for Fire Protection Engineering," Society of Fire Protection Engineers, Bethesda, MD, 2000. This paper is a summary of the full research agenda report.

The workshop concluded with a plenary session where each of the breakout groups presented the research needs that their group identified as the highest priority. The results of the breakout group discussions were summarized and agreement reached on the highest needs. Forms were given to workshop participants for them to evaluate the impact, cost, feasibility and timeframe for the research needs identified at the workshop. These forms were completed after the workshop and returned to the workshop host.

The workshop attendees identified four primary areas where research is most urgently needed: fire phenomena, human behavior, risk and data.

FIRE PHENOMENA

A common issue in the breakout groups was that "gaps in current design methods result in excessive conservatism."

An understanding of fire phenomena forms the foundation upon which engineered fire protection is based. Consideration of the effects of fire on people, buildings, property or the environment first begins with consideration of the types of fires that might be expected and how those fires would behave (fire growth, heat release rate, smoke production, etc.). While there are significant opportunities for improvement in design that would result from research in other areas, strengthening the knowledge base in fire phenomena would lead to improvements in all designs.

Current predictions of fire phenomena are too often based on rules of thumb, extrapolation from small scale testing or expensive large scale testing. While these methods are based on a significant body of experience, the margin between predictions and actual behavior is often unknown, and the applicability of these methods to new fire hazards, new technologies, and any changes in the future, cannot be assumed.

Research is needed to better predict fire growth and to predict heat release rates from fully developed fires in large or elongated enclosures. Other areas where research is needed include thermal detector response in installations other than under horizontal, unobstructed ceilings, smoke detector response and suppression system efficacy.

However, a greater understanding of fire phenomena in itself is not sufficient. It is necessary to transfer knowledge gained through research into fire protection engineering practice through the development of models and other tools. A greater understanding of fire phenomena which is readily applicable through models will lead to better and more cost effective fire protection.

HUMAN BEHAVIOR

A participant in one of the breakout groups noted that "fire protection system designs assume that people will leave buildings in the event of fires. However, this often does not happen; ... we need to design for these actions." Similar remarks were made in each of the other breakout groups.

Designs that are based solely on fire behavior, equipment performance, and materials response overlook a significant factor that can often by the key to the outcome of a fire: human behavior,

human performance, and human response. To provide better life safety, it is necessary to better understand the actions that people will take in response to a fire.

Workshop participants identified a need for research into the decisions people make in response to fire cues and pre-movement delays. Research is also needed into the impact of the fire environment on human behavior, particularly sub-lethal health effects, effects on behavior and animal to human conversions for data based on animal studies. Research into the variability of human behavior is also needed.

As with fire phenomena, increased understanding of human behavior in fire must be quantitative and predictive. Readily available models will be needed to facilitate the consideration of human behavior in engineered fire protection system design. An increased understanding of human behavior in fire will lead to more efficient life safety systems, thus providing necessary protection at acceptable cost.

RISK MANAGEMENT

The engineering community generally recognizes risk as a product of probability and consequence. However, risk is much broader than this simple equation suggests, for example, addressing issues of uncertainty.

As one workshop participant noted, "it is not possible to incorporate society's perception of acceptable risk into design, particularly as perception of 'acceptable risk' varies." Similar sentiments were expressed by others.

Fire protection engineering has typically focused only on the consequence (or hazard) part of risk. To bring about significant cost-benefit improvements in fire protection engineering design, and to better focus fire protection resources where they are needed most, research is needed into the application of risk management. Using risk management in fire protection engineering practice requires definition of the level of risk that society is willing to accept and a risk management framework.

Definition of what constitutes an acceptable risk will require the input and concurrence of public policy makers. Since definition of risk involves deciding how much loss is acceptable, this can be a politically challenging task. However, lessons can be learned from other industries, such as the automobile and aircraft industries.

Once an acceptable level of risk is established, it will become necessary to design to meet this level of risk. This will require the development of a risk analysis framework that considers risk exposure and the costs, both initial and lifecycle, of any protection methods used.

As risk analysis has been applied in other engineering disciplines, one can look to these disciplines as a starting point. The risk analysis tools used in other engineering disciplines can be evaluated for their applicability to fire protection engineering, and possibly modified accordingly.

DATA

Each of the breakout groups expressed concern with the paucity of data that is available to fire protection engineers. Statements made included: "A significant amount of fire testing is conducted; however, the results from these tests are not readily available," and "forensic research is needed to capture performance data of real fires."

Data forms the input to engineering tools and calculations. However, data must be readily available and have known confidence. Data is needed to assess how products and materials would behave in fires. Reliability data is needed for fire protection systems. Forensic data is needed to learn more about how fires are started and for feedback regarding failures and successes. Human behavior data is needed to learn more about what types of people can be expected in different occupancies, and what types of actions they might take that could lead to fires or alter the course of fires.

It is paramount that data be widely available. Data is often difficult to obtain. A central contact point is needed for fire data. Also, data must be maintained in such a manner that it can be used with confidence.

SUMMARY

Realization of the research needs identified in this agenda will allow fire protection engineers to achieve a number of societal benefits: improved life safety, reduction of fire related costs and improved environmental protection. Additionally, others stand to benefit from an increased understanding of the physical world – product manufacturers, building owners, insurers, the fire service and the public at large.

Implementing the research agenda will not be easy. It will require a significant financial investment and several years to achieve it. Presently, there are a number of organizations involved in research, including both private companies and governmental agencies around the world. Each of these organizations will have a role to play in implementing the research agenda.

Many stand to benefit from the results of the research identified in this agenda. Therefore, it is not reasonable to depend only on the organizations now involved in fire research to conduct the necessary research with the resources they currently have available. Collaboration and partnerships will be crucial to the success of implementing this agenda.

Additionally, a champion will be needed to coalesce the diverse interests that will need to come together to ensure successful implementation of the agenda. This champion will need to advocate the agenda, break down inter-organizational barriers, and oversee and monitor completion of agenda topics.

Realization of the research agenda will be no small undertaking. However, the benefits far outweigh the costs. Implementation of the research agenda will bring about significant improvements that will improve safety and reduce fire related costs.

WORKSHOP ATTENDEES

Name	Organization
Vytenis Babrauskas	Fire Science & Technology, Inc.
Mike Balch	Australian Building Codes Board
Carl Baldassarra	Schrimer Engineering Corp.
John Bender	National Association of State Fire Marshals
Craig Beyler	Hughes Associates
Jim Beyreis	Underwriters Laboratories, Inc
Jason Boren	Bechtel
Robert Boyer	Edwards Systems Technology
Doug Brandes	Duke Power
Murray Cappers	J&H Marsh and McLennan
Larry Maruskan	US Fire Administration
Geoff Cox	Building Research Establishment
Dick Crouse	American Petroleum Institute
Richard Custer	Custer-Powell, Inc.
Tom Daly	Hilton Hotels
Robert D'Angelo	U.S. Army
Mr. Ron de Veer	Queensland Department of Communication & Information
Dougal Drysdale	University of Edinburgh
Ken Dungan	Risk Technologies, LLC
Fred Emerson	Nuclear Energy Institute
William Erny	American Petroleum Institute
Lenny Farelo	Intel Corporation
Paul Fitzgerald	FM Research Corp.
Jay Fleming	Boston Fire Department
Arnold Garson	Cerberus Pyrotronics
Casey Grant	National Fire Protection Association
LT Andy Grenier	U.S. Coast Guard
John Hall	National Fire Protection Association
Rich Hansen	U.S. Coast Guard
Paul Heilstedt	Building Officials and Code Administrators, International
Wayne Holmes	Hartford Steam Boiler Professional Loss Control
Tom Jaeger	Gage-Babcock & Associates
Marc Janssens	Southwest Research Institute
Robert Jonsson	Lund University
John Klote	American Society of Heating, Refrigeration and Air Conditioning Engineers
Bill Koffel	Koffel Associates
Matti Kokkala	VTT Building Technology

Bruce Larcomb	Building Officials and Code Administrators International
Larry Little	Commonwealth Scientific and Industrial Research Organization.
Dave Lucht	Worcester Polytechnic Institute
John MacGreggor	Building Industry Authority
Robert Malanga	Union Camp Corporation
Chris Marrion	Arup Fire
John McFassel	U.S. Army Aberdeen Test Center
Joseph Messersmith	Portland Cement Association
Fred Mowrer	University of Maryland
Frederick Mulhaupt	Fire Protection Research Foundation
Bijan Najafi	SAIC
Harold Nelson	Hughes Associates
David Notley	SAIC
John Nutt	Ove Arup & Partners
Michael O'Hara	MountainStar Enterprises
Jim Quintiere	University of Maryland
Jim Quiter	The RJA Group, Inc.
Ken Richardson	Ken Richardson Fire Technologies, Inc
Mickey Reiss	The RJA Group, Inc.
Robert Schifiliti	RP Schifiliti Associates, Inc.
Jim Shields	University of Ulster Fire SERT Centre
Paul Shipp	USG Corporation
Nathan Siu	Nuclear Regulatory Commission
Warren Stocker	Safeway Inc.
Kuma Sumathipala	American Forest & Paper Association
Harry Taback	J&H Marsh & McLennan
William Tangye	Southern Building Code Congress, International
Ian Thomas	Centre for Environmental Safety and Risk Engineering
Jon Traw	International Conference of Building Officials
Beth Tubbs	International Conference of Building Officials
Bob Weber	Clark County Nevada
Dave Wechsler	Union Carbide
Jack Woycheese	Gage-Babcock & Associates

ACKNOWLEDGEMENTS

The research agenda is the product of all of the participants in the SFPE Research Agenda Workshop. Financial support from the National Institute of Standards & Technology is also greatly appreciated (Grant No. 60NANB8D0047).